

Oregon Agricultural
Experiment Station

Bulletin No. 25.

April, 1893.

ENTOMOLOGY:

CODLING MOTM AND HOP LOUSE.

ECONOMIC ZOOLOGY:

GOPMERS AND MOLES.

F. L. WASHBURN

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REPORT ON WORK WITH THE CODLING MOTH.

The following is a brief account of what has been accomplished with this pest in 1892. From the results attained it is believed that the number of necessary sprayings, and consequently the expense, can be reduced, and still accomplish the desired end.

In addition to the field work, the duration of the different stages of the insect's life has been carefully studied, and the result is suggestive of points of value to the horticulturist.

All plates and cuts in this and other articles of this bulletin (except Figs. 5 and 10) have been made from photographs by our photographer Mr. E. Pernot, and we wish to hereby acknowledge our appreciation of his pains-taking efforts. To Mr. Coote, the Station Horticulturist, our thanks are due for various courtesies.

In these experiments the trees used were from 35 to 40 years old. Only a few trees were taken in each case. As only one solution was a decided improvement over anything used hitherto, we will pass rapidly over those three which met with only ordinary success.

Exp. No. 1 Flour paste and Paris green.—This was tried at the suggestion of an orchardist in Southern Oregon, who believed the paste could best withstand rain and would form an additional attraction to the moth. Two lbs. of flour were made into a paste with 6 quarts of water, added to 12 gal. water and 1 oz of paris green stirred into this mixture. This was not satisfactory.

Exp. No. 2 Paris Green alone.—This is the ordinary solution in general use,—1 lb. paris green to 300 gals. of water (1 lb to 300 gal. is strong enough) and about 15 lbs of soft or whale oil soap added to this to cause an even spreading of the liquid. The effect of the use of this mixture has been reported in Bulletin No. 10, and nothing further need be said here. It is a good agent but experience indicates that a comparatively large number of sprayings is necessary, with an interval of only 16 or 17 days between applications. This is corroborated by reports from various orchardists.

Exp. No. 3 IXL and Soap.—IXL is an insecticide for sale by Wm. F. Beck & Co., 117 California St. San Francisco, and 26 N. Front St., Portland, Oregon, and is apparently rapidly coming into favor. It sells in Portland at 4 cents per lb, in barrels (500 lbs to the bbl.); 4½ cents per lb,

per 60 lb. box; and 5 cents per lb in bricks, any quantity. A qualitative analysis of this agent by Prof. Lotz, our Station Chemist, shows that it contains lime, sulphur, and salt, or more exactly Calcic hydrate, Sodid Chloride, Calcic Sulphide and Sodid Sulphide. It was reported to contain no arsenic. The proportions used in this experiment were 1 lb IXL, 1 lb whale oil soap, 6 gals. water. As mentioned above the soap is used to cause the liquid to spread smoothly and evenly over the fruit, a very necessary thing.

The recipe given by the manufacturers of IXL for the codling moth, and we have experimented with this also, is similar, but the soap is omitted. The effect of either of these mixtures is not so good as the compound used in

Exp. No. 4 IXL and Paris Green and Soap.—1 lb. IXL to every 16 gals. of water, and to this paris green added in the proportions of 1 lb. to every 300 gals. of liquid. About 15 lbs. of whale oil soap (we believe soft soap would have been as efficacious) were added to this 300 gals. The IXL was crushed to pieces about the size of a hen's egg and sufficient hot water poured on to cover it. It was then added to the water, as well as the soap, *which latter has first been thoroughly dissolved.* The paris green was then added *and the mixture kept stirred when spraying.* We have always found it expedient to mix the paris green with a small amount of water first (if it is of good quality it will readily mix) and then pour the creamy mass into our spraying liquid.

Two lots of trees were treated with this, one receiving the first spraying May 26th another June 15th. Both lots made a very good showing, those last sprayed appearing as well at the end of the season as the former. The cost of labor and material in this experiment was 7 cents per tree (35-40 years old) for each spraying.

OBSERVATIONS ON THE LIFE HISTORY OF THE MOTH. MISCELLANEOUS NOTES, ETC.

A diligent study has been made of the length of time occupied in the different stages of the life of the codling moth. In the Fall of 1891 a breeding-cage was placed out-of-doors, in a situation where it could have, as nearly as possible, the same natural conditions, as regards temperature and moisture, as the insect would be subjected to during the winter in its natural habitat. In this cage several cocoons were placed.

From May 16th to May 26th, 1892, moths emerged from these cocoons very rapidly. From these, from specimens subsequently secured, and from observations in the field, the following data have been conclusively determined: *Life of moth 10 to 15 days, pairing and egg laying taking place during the latter part of that time, after which the moths die.* The eggs are semi-transparent cloudy white with yellowish tinge, the shell finely sculptured (see Fig. 1 Plate 1) from 1-fifteenth to 1-twentieth inches in diameter, and are plastered on the surface of the apple. Each female moth lays a large number of eggs, but apparently only a certain proportion of these eggs develop, as many were found flattened and dead, looking like small trout scales on sound apples. *The eggs hatch in from 5 to 10 days.* The larvæ when first hatched are hardly a twentieth of an inch long, and, in the cases

under observation, broke or ate their way through the shell, and entered the apple somewhere else than at the spot occupied by the egg. I cannot say however that they do *not* eat *directly into the apple without breaking the shell*. The life of the larvæ in the apple lasts for *about 4 weeks, or a little less*, at the *expiration of which time, they leave the apple and remain in the pupa state three weeks*, when they emerge as moths ready to repeat their destructive work. The last brood in the Fall, however, do not leave the cocoon until spring, remaining as larvæ in their silken nests throughout the winter. It is a noteworthy fact that the eggs of the first brood are not necessarily laid in the calyx end of the young fruit, as eggs were found the past season, (June 28,) long before any wormy apples appeared, and hence belonging to first brood, *placed on both the sides and the top of the fruit*.

The data above cited should be convincing proofs that the moth is at least four brooded in Oregon. To make this still clearer the above facts are embodied below in a table easily understood.

In order, however, that there may be no room for question we will place the date of the appearance of the first moths on June 1st, at about which time we noticed moths in the orchard, four days after their appearance in the feeding cage. The columns are lettered A. B. C. D. E. Series A is continued under C. Series B represents a number of moths which Mr. Coote brought us from his apple room June 20th.* Series B is continued under D, and C, which is continued from A, is concluded under E.

	A	B	C	D	E
Moths emerge from cocoons.....	June 1	June 20	Aug.	Aug. 28	Oct. 17
Egg laying (when moths are about 10 days old.)	June 11	June 30	Aug. 19	Sept. 7	Oct. 27
Hatching of eggs (5-10 days.)	June 21	July 10	Aug. 29	Sept 17	Nov. 6
Life of larvæ in apple (4 weeks.)	July 19	Aug. 7	Sept. 26	Oct. 15	Dec. 4
End of larval and pupal stages in cocoon (3 weeks) and emergence of Moths.	Aug. 9	Aug. 28	Oct. 17	Nov. 5 or the following spring.	Emerge the following spring.

The extreme length of the different periods has been used in the table, in order to show how easily four broods can appear during our long warm season. These broods by no means appear with regularity, but there are evidently many individual variations; some eggs hatch more quickly than others, some larvae mature more rapidly than their fellows, or some eggs may be laid a few days earlier or later, according to circumstances. It is evident that there is, consequently, considerable irregularity in the appearance of the moths. But the data upon which the above table is constructed are correct, and the dates given are as nearly exact as circumstances allow.

As to the larvæ which leave the apples about Oct. 15th, it cannot be said with certainty whether they all emerge from the pupa stage Nov. 5th or live in their cocoons as larvae during the winter, passing through their

* All apples had been removed from this room in January; the moths, therefore, which had pupated in cracks in the floor, were from a late brood of the preceeding season. They were unworn and apparently just emerged from pupa cases.

transformations in fruit houses and store rooms. The finding of a moth out-of-doors as late as Nov. 15th indicates that some, at least, pass through their transformation in the Fall.

There is no question but that the larvæ which enter the pupa stage Sept. 26th (column C) transform into moths the same season, and begin a life cycle which is completed where the apples are stored. Boxes and fruit houses which have contained unsprayed apples, if carefully examined toward spring will disclose, in cracks and crevices, hundreds of cocoons containing larvæ. That there is a marked overlapping of broods in the Autumn, an increasing abundance of the pest and a consequent serious damage to fruit at this time is shown by the finding of apples in Sept. and Oct. with full grown larvae, larvae a week or less old, and others of intermediate ages. This same discrepancy in ages of larvæ has been observed earlier in the season, all indicating the irregularity of the appearance of the moths and the variation in time required by the eggs to hatch etc.

The first brood of moths here, those earliest on wing, do not appear to affect the pears. This same thing has been observed in some of the Eastern States.

Sept. 18 1892, an egg, apparently fresh laid, found on Duchess pear.

Shortly before, upon, and a few days after Oct. 18, cocoons were found under bands on trees containing larvae which did not change to the pupa stage while under examination, evidently destined not to complete their transformation until the following Spring.

A few apples upon which occurred eggs were allowed to remain a few moments in the IXL, paris green and soap solution, but subsequently these eggs hatched. This would seem to indicate that the solution does not affect the egg itself, but cannot be regarded as conclusive. The young larvae, in the cases observed, invariably left the shell as stated before, entering the apple at some other point. If such is always the case, they are, in properly sprayed apples, certain to get some of the poison.

In some instances an egg or eggs were found on apples in which immature larvae had already been found. There would be, then, later, two or more larvae in one apple at the same time.

We have just tested some whale oil soap made by the Arctic Oil works and for sale by The Blumaur Frank Drug Co., Portland, at 7 cents per lb in small lots. We find it to be 80 per cent soap, dark and firm and presume it might be purchased for a little less if obtained in large quantities.

We have used at the Station a soap sold by the old firm of Taylor Nasen and Co., San Francisco, for which we pay 3 cents per lb. in 400 lb. lots, and which the manufacturers claim to be pure whale oil soap. It has answered our purpose very well, yet evidently contains more or less water,—it has not the firmness and solidity of the first soap mentioned.

Summarizing.

Observations on the habits of the moth, extending through three years, together with last seasons investigations, have convinced me that orchardists begin spraying altogether too early. The absurdity, as well as the danger to bees, in spraying the bloom, has been clearly demonstrated before

this, and it is very evident that the first spraying need not be given until quite a time after the bloom has fallen. This theory is borne out by last year's work in which trees sprayed for the first time with IXL and paris green and soap as late as June 15th compared very favorably with those first sprayed May 26th. Had we sprayed last season anytime between June 1st and June 6th we should have regarded it as early enough. Last season was rather backward, yet we shall govern our actions this year by last year's observations, spraying possibly a little earlier or a little later than June 1—6 as circumstances seem to dictate.

Inasmuch as the IXL, paris green and soap gave the best satisfaction last year, apples going three and four weeks between sprayings, we shall try the same thing in the same proportions this season, spraying for the first time as indicated above and allowing three weeks (granting it does not rain heavily immediately after a spraying, when it might be necessary to repeat) to elapse between the first and second and second and third sprayings. To another lot of trees a fourth spraying will be given, four weeks after the third. It is possible that the late apples may need this, but it is believed, if the trees sprayed are at a distance from neglected orchards, or if all orchardists in a neighborhood will co-operate in the good work, that three faithful treatments will bring very good results.

While we are hardly prepared to indorse all that the manufacturers of IXL claim for it, and while this coming season's work may refute entirely the good results obtained last summer, we are inclined to believe as far as we have seen that it is a good agent in the hands of orchardists. The apple scab (*Fusicladium dentriticum*) was less prevalent on trees where IXL was used (though this must not be regarded as conclusive evidence of its effectiveness in that direction) and the branch form of Woolly Aphis was kept completely in check, a little extra time being taken, when spray for the codling moth, to direct the spray forcibly against the colonies of this pest.

Banding, *i. e.* wrapping a strip of old burlap about the tree has proved a most valuable adjunct to spraying and will be practiced this season; the bands will be examined every five or six days and the larvæ found beneath will be killed.

Pears evidently do not require any spraying until about the time the second brood is on the wing.

From two to three gallons should be enough liquid to spray a tree from 30 to 40 years old, smaller trees requiring less.

This department has found that Paris Green gives the best satisfaction, and the experience of Eastern workers appears to corroborate this, yet many orchardists in Oregon report in favor of London Purple.

Our storerooms and fruithouses are veritable nurseries for this pest, and send out hundreds of volunteers every Spring. This is overcome in some sections by having gauze over the window or windows and catching and killing the moths in their efforts to escape.

If the orchardist is over anxious as to the efficacy of only three spray-

ings, or thinks his first spraying has not been thorough, he might safely interpose a spraying ten days after the first.

As stated before 7 cents per treatment will cover the expense, both labor and material, of using the above mixture on large trees.

The later we can safely spray for the first time, the less likelihood of interference by rain.

EXPLANATION OF PLATES I AND II.

Fig. 1, Pl. I, is the egg of a Codling Moth, enlarged about 70 diameters. It was made from a photograph of a camera lucida drawing. The egg is nearly ready to hatch and the embryo larva can be seen beneath the shell.

Fig. 2, Pl. I, is a photograph of a few pinned insects, natural size. The two upper left hand specimens are Codling Moths. Many of our farmers have no idea of the size and appearance of this pest. One of these moths is figured with expanded wings, the other with wings folded.

The clear winged, wasp-like looking moth on the right, the last figure on upper line is the imago of the Peach Borer, *Sannania Pacifica* (Riley), whose eggs hatch into the worm we find in our peach, plum, and prune trees.

The first four insects in the lower line are *Hippodamia convergens* (Guer.) or "Lady Birds," beneficial beetles which consume, with the aid of their larvae, hundreds of Woolly Aphis, Hop Lice, Green Aphis etc. The last beetle on the right in the lower line is an injurious form known as "The 12-spotted Diabrotica" *Diabrotica 12-punctata* (Oliv.) and in size and appearance it looks not unlike the "Lady Birds," but its habits, of course, are entirely different.

DESCRIPTION OF SPRAYING OUTFIT IN USE AT THE STATION.

Plate II illustrates the apparatus with which we spray. A galvanized iron tank capable of holding about 160 gals. is fastened to a frame made of 2X12 plank, which in turn is hooked on to a wagon bed. When it is necessary to use a warm solution, a sheet iron stove is fitted under the tank, its door flush with the rear end. The smoke stack from this runs forward, below tank, out through a hole in the frame at the anterior end, and ends in an upright piece about 5 feet long (not shown in plate).

We use a Beam Pump No. 5 and it gives good satisfaction. Its receiving hose screws onto a faucet leading from the anterior end of tank, and its two pieces of discharge hose are connected with bamboo extensions as shown in cut.

A wooden cover fits tightly on to tank in the centre of which is a wide slit two feet long, through which a paddle is inserted and the liquid kept stirred while being sprayed. A good and cheap improvement on this method of stirring, which we propose to adopt, is to have a series of paddles, hung from the cover, all worked by a lever which the driver could occasionally push back and forth. When not in use this tank fits into a brick furnace, and is used for compounding any insecticide which requires heat. A desirable addition, which we have not yet arranged, is a tackle to hoist the tank, when full, from off the furnace, and to roll it on to wagon bed,



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PLATE I.

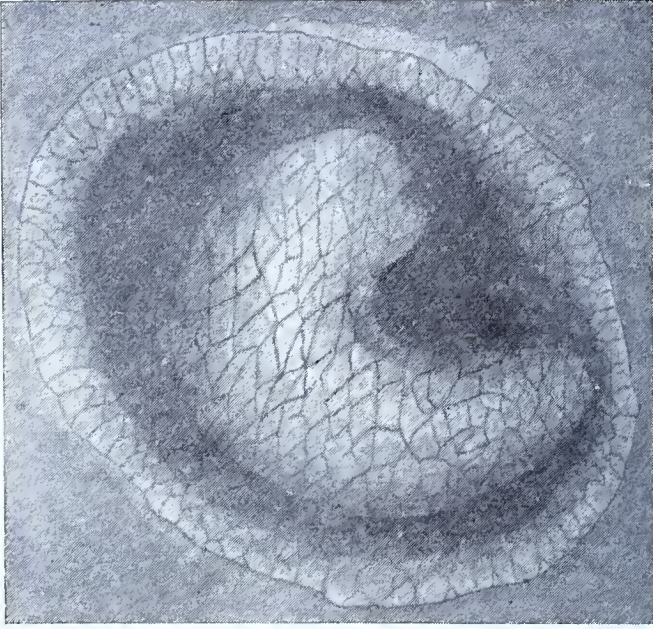


FIG. 1.—Egg of Codling Moth, much enlarged. (Original.)



FIG. 2.—A few pinned Insects, natural size.

PLATE II.



THE HOP LOUSE.

(*Phorodon humuli*.—Schränk.)

Part of bulletin No. 10 from the experiment station issued in April 1891 was devoted to this subject, giving the life history of the pest, observations on its habits etc. in Oregon, preventive measures and remedies.

Since that was written reports have come from many hop growers of the state corroborating the statement that wild plums, or seedlings, and, in a few instances, a very few,—cultivated plums and prunes were the place of deposit of the eggs which last through the winter and hatch in the spring. The migration of the hop louse from plum to hop and hop to plum is not now questioned by observant growers notwithstanding the opposition which this statement met with two years ago.

On p. 32 of Bulletin No. 10 methods of prevention and remedies were given, viz. (a) clearing away superfluous timber about yards, letting in sun and breeze; (b) cutting and burning all thickets of plum seedlings, wild plums etc. in the vicinity of hop yards; (c) avoiding importation of eggs on plum scions from localities infested with hop louse; (d) cutting and burning the vines directly after picking; (e) spraying, to kill eggs, any valuable plums or prunes upon which eggs occur, with strong caustic solutions, when the buds are dormant; (f) spraying the same trees in Spring and Fall while the louse is found thereon, using any of the sprays recommended for Summer treatment against plant lice; (g) spraying the hop vines themselves during the summer season with any of the following standard solutions hitherto suggested, viz., Quassia and Soap, Kerosene emulsion, Tobacco and Soap.

Further study of this subject during the two years elapsing since the above was written has brought out some points of especial value to hop growers and the object of this treatise is to present, in a brief form, these new facts. There is no hop yard at the Station or in the near vicinity, and much of this information has been obtained by visiting yards, and talking with growers. Our thanks are due Mr. T. D. Linton, Mr. G. Muecke, Mr. Bents, Mr. Reuben Wright, Mr. S. Smeed, and others for various courtesies.

No reason has been offered for in any way changing the recommendation given under (a) above, it being a noticeable fact that hops planted on the uplands are freer from lice than those in river bottoms. We still recommend (b) as in a measure, abating the evil, but it should be borne in mind that this insect while in the winged form, may migrate or be carried by the wind a long distance from the hops hence this measure is only part of the work and does not afford complete exemption. No comment is needed on [c], its value is apparent. Regarding cutting and burning the vines directly after picking, [d] much can be said. The most contradictory reports have been received relative to this practice, which in some places is in general use. Some of our growers claim that if cut high enough [about 3 or 4 feet] and tied at the end, no injurious results follow and others assert that whenever and wherever cut, the crop of the following year is injured and may be a failure. *The weight of testimony appears to be decidedly against cutting, even when lifting out the poles,* careful workers asserting that the

pole can be rotated in such a way that it can be slipped up through the coiled vines, only necessitating the possible cutting of one or two stems. Further, we are privileged to illustrate and describe a method of trellising a yard which does away with the necessity of using poles, and consequently of pulling them up. The burning of vines, immediately after picking is, of course, to kill the lice before they may have migrated to the plum where they pair. It should never be done on the yard, and, if the measures recommended elsewhere for summer use, are carefully carried out, it may be postponed to suit the convenience of the grower.

The propositions [e] and [f] need no comment, they hold good anywhere and their use is regulated by the judgement of the growers. Spraying the hop vines themselves during the summer season [g] is the only true resource of the hop grower and all progressive hop men unite in saying that they regard spraying their hops as much a necessity as their cultivation and that in estimating their year's expenses, the cost of spraying is always included. All other preventives catalogued are of little value if the grower thinks he can thereby avoid spraying the vines during the summer. They may alleviate the evil to some extent, but it would be folly to rely upon them alone.

Granted then that spraying the vines during the summer is a necessity, and it surely is, the question arises, "what material have our hop growers found most efficient"?

Kerosene emulsion was one of the spraying solutions recommended in Bulletin No. 10; it has been used in the East on hops and to some extent on this coast, and is one of our most efficacious insecticides for plant lice. Kerosene however, as the reader knows, is fatal to vegetation, and to properly compound the emulsion requires great care. Its efficacy depends so largely on its proper manufacture, and there are so many chances for an unprofessional to make a disastrous error in its preparation and use, that growers, in view of safer compounds, should be cautioned against it. It should not be used when hops are in bur. Conversation and correspondence with very many growers lead us to say it is *not a safe insecticide in the hands of our hop growers*.

Quassia and Soap.—This is highly spoken of, and barring the expense of the chips and the time consumed in extracting, is recommended. Quassia chips are for sale by parties here and in the State of Washington for about 6 cents per lb. Whale oil soap can be obtained in bulk from 3 cents per lb. to 6 cents or 7 cents per lb., the latter guaranteed to be 80 per cent strength.

Tobacco [stems] and Soap.—This has given such perfect satisfaction, after repeated trials that we unhesitatingly endorse it. Furthermore its cheapness, and the fact that it does not necessarily call for whale-oil soap [though this may be used] but an inexpensive home made soap, makes it a desirable agent. Mr. G. Muecke of Aurora Mills Or., has used it and is delighted with its efficacy. The stems can be used twice and then are valuable as a fertilizer and preventive of grub worms.

The solution should be of such a strength that the liquid has a decided tobacco color. Strain after steeping. Add enough soap [cheap soft soap or

whale oil soap] to make the liquid spread evenly over the leaves. Mr. M. states that in England tobacco is recognized as better than quassia in this direction, but that there tobacco is more expensive; here the tobacco is the cheaper of the two.

Two cents per lb., is charged at factory in Corvallis for waste tobacco stems, and presumably the price is the same elsewhere.

The supply from these sources is limited and Mr. Muecke has agreed to sell tobacco stems [gathered up from various sources in San Francisco] for 3½ cents per lb., as long as the supply in his storehouse lasts. This figure, which covers the cost of transportation from San Francisco to Aurora Mills, is nominal compared to the cost of quassia.

Win. Brown of Salem sells quassia chips made here from quassia logs shipped from New York, for 6 cents per lb., and whale oil soap which he guarantees to be 80 per cent., for 6 cents per lb. He is also agent for the Roberts' Roller Sprayer.

Regarding apparatus for spraying, the growers must be guided by their preferences. The Bean Pump, manufactured by the Bean Spray Pump Co. at San Jose California is highly spoken of, and the experiment station can indorse this pump for general use. The Mitchell Lewis & Staver Co are agents for this pump, the different sizes selling all the way from \$16.00, to \$54.00. In California the Champion Spray Pump also meets with approval sold by Woodin & Little S. F.

The Puyallup Roller Sprayer sold by Meeker & Co. of Puyallup Washington, and the Roberts Sprayer made by Roberts of the same place, both working by horse power, are advertised. We cannot, at this date, speak of their comparative merits.

MISCELLANEOUS NOTES.

Young lice on the lower surface of leaves if exposed to the rays of a hot sun, quickly die. A number of growers taking advantage of this, pick the lower leaves when first infested and leave them on the ground, *their undersides uppermost*.

A number of prominent growers report very favorably on the use of sheep in the hop yard. They must be removed as soon as they have eaten the lower leaves and begin to paw the poles in their efforts to reach the foliage above them. If they are not disposed to eat hop leaves at first, one grower suggested picking a few leaves, sprinkling them with a little salt water, and then feeding. The sheep soon acquire a fondness for the natural leaf.

The time for the first spraying is when the lice first appear in the yard. Growers should, therefore, watch the vines for the first evidences of the presence of the pest.

In no instance has a genuine hop louse been sent to the Station from any other plant than a hop or plum or prune tree except a few sent by S. A. Clarke of Salem on mint leaves. This mint however grew among plum or prune trees which were infested, and the occurrence on the mint may have been accidental.

Hop lice which were found on Petite prune have been sent to this department in a few instances. The Italian prune has not been touched as far

as is known. The louse does not remain on any plum or prune tree long enough to cause appreciable injury.

Mr. Smeed of Waterville writes that the German Grape and English Cluster have been badly infected. He has three varieties of early hops ripening from 10 days to 2 weeks before the English Cluster. It has never been necessary to spray these, though adjoining infested yards of other varieties.

The following diary memoranda may be of interest:

April 12, 1892.—Many Green Aphis [*A. mali*] sent in from two localities under the impression that they were the hop louse.

May 16.—Genuine hop lice received from T. D. Linton of Eugene found on Blue Plum: Mr. Wells of Buena Vista reports winged hop lice on his hop vines. Specimens were sent, and proved to be *Siphonophora* and not hop lice.

May 18.—Specimens of hop lice received from Capt. Wuestney Napavine Wash., found on an unnamed plum tree.

May 27, 92.—Winged and wingless hop lice received from Salem Or., found on Plum trees.

June 1, 1892.—Specimens of hop louse received from T. D. Linton of Eugene, found on Hop Vines. The above dates indicate the time of migration from plum to hops.

Mr. B. Grimm of Aurora finds IXL in the proportions of 1 lb. to 10 gals of water a good wash for the hop vines. Capt. Wuestney of Napavine Wash. speaks highly of its effect on the vines. He reports unfavorably of the Woodbury Tree Wash. G. Muecke of Aurora also reports unfavorably on Woodbury Tree Wash as far as hops are concerned.

Mr. Alec. Holmes of Derry Or. is reported as finding elittim-wood bark (*Rhamnus*) as good for hop lice as quassia. Another party claims that the vegetable pest known as "Man-in-the-ground" (*Megarrhiza Oregona*) is a good remedy. We have had no opportunity of verifying this.

Too early picking, occasioned by the attacks of vermin, apparently injure the vines. This seems especially true of the German Grape and English Cluster varieties.

Mr. Muecke states that he "sprayed with the tobacco solution up to picking time, and that after the hops were dried and baled various experts could find no trace of tobacco smell."

A TRELLIS FOR HOP VINES.

Through the courtesy of Mr. Reuben Wright of Mulino Or. we are enabled to present the following figure and description of a method of trellising which he has adopted in his yard. The principle is not new, though some of the details may be innovations.

The advantages of this method over the old system of poling are apparent; the growth is more even; at least one third of the spraying material is saved; in picking, the two wires are raised off the pins with a pole, and they then are low enough to pick all the burs, there is thus no need of loosening the ends.

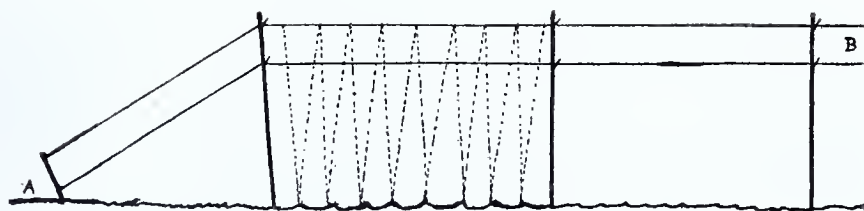


FIG. 3.—A Trellis for Hops.

Explanation of figure:—A is placed on surface of ground and by the side of an anchor post. This anchor post is 6 in. $\times$ 6 in. and 7 feet long, $4\frac{1}{2}$ feet of this being below the surface, and it inclines at an angle of 35 degrees. The anchor post is 10 feet from first support and has its counter part at the other end of the row. Supports consisting of cedar, each equal to a 4 $\times$ 4 in size, are placed between the two anchors, nine hills intervening between every two supports (only eight are indicated in the fig.) The support nearest the anchor leans slightly. Each support is 11 ft. long, 2 ft. being below the surface. Six inches from the top of each support a $\frac{3}{4}$ in. wooden pin is inserted, slanting enough to hold wire securely.

Thirty inches lower down is a similar pin. As indicated in the figure there are two galvanized iron wires, the upper one size No. 12, the lower No. 13; the letter B is placed between the wires. The dotted lines in figure represent common cotton twine, two strings from each hill fastened to the two wires. About five pounds of this twine is used to the acre.

The method of raising the wires and stringing is as follows: the supports and anchors in, and the wires stretched through the yard, a ten penny nail is driven into each support five feet from the ground and another one thirty inches lower down. The wires are then fastened to anchor post at one end, raised to the nails, the upper wire lying on the upper nail, and the lower on the one below. The wires are then pulled as tight as possible and wrapped around the anchor post at the other end. The twine is cut into pieces ten feet long. Two of these pieces are used for each hill (see dotted lines in figure) each piece being passed round bottom wire once and tied firmly to upper wire. After the row is strung raise the wires to the wooden pins, and stretch tight, the tighter the better. A fir splint six inches long is driven into each hill, after the strings are fastened to it, by two half hitches. These strings should be taut from hill to wires. The twine costs 90 cents per acre, No. 13 wire costs \$15. per acre. The cost of the timber for anchors and supports and splitting and hauling differs, of course, with circumstances.

Mr. Wright will doubtless be willing to answer any further inquiries regarding this trellis.

GOPHERS AND MOLES.

"Well said, old mole! can't work 'i the ground so fast?"

The order of animals known as Rodentia or "gnawers" comprises a very large share of that portion of the class of *Mammalia* which is found in North America. The order is characterized by the presence of chisel-like incisor teeth in the upper and lower jaw with which their gnawing is accomplished. Our rats, mice, squirrels, marmots, rabbits, and gophers are examples of this order and illustrate this dental characteristic.

The Pocket Gophers or Pouched Rats, prominent rodent pests, occur in a family called *Geomyidae* and are widely distributed over the United States. The special individual which occurs in such destructive abundance on this coast, and forms part subject of this sketch is *Thomomys bulbivorus*. Against this pest and against our common mole *Scapanus Townsendii*, which is also so unfortunate as to be regarded in an unfavorable light, this department has worked for the past two years endeavoring to find remedies which would afford, at least, some relief.

The mole does not belong to the same order as the gophers, its habits are different; structurally it is widely different, and its small sharp teeth all much alike, seem especially adapted to crushing and masticating insects, grubs, worms, etc. In fact it belongs to the order *Insectivora* which means "insect eating." The mole's reputation among scientists as a non-vegetarian has been for a long time so firmly established, that any charges of its eating roots or bulbs or seeds has been emphatically denied. This belief in the mole's innocence was entertained by many of our leading workers in this class of animals, and it would seem now, in spite of unfavorable evidence, that, apart from the unsightly mounds on our lawns and the disarrangement of soil in our flower beds, and even admitting his occasional fondness for peas and bulbs, that he cannot be placed in the same category with the pocket gopher, and merits clemency of treatment at our hands. Yet the decree having gone forth that the mole is a pest seals his fate as far as human intention goes and hence we seek for means of killing him.

To return to the Pocket Gopher. Their mounds are familiar to almost every resident of the State.

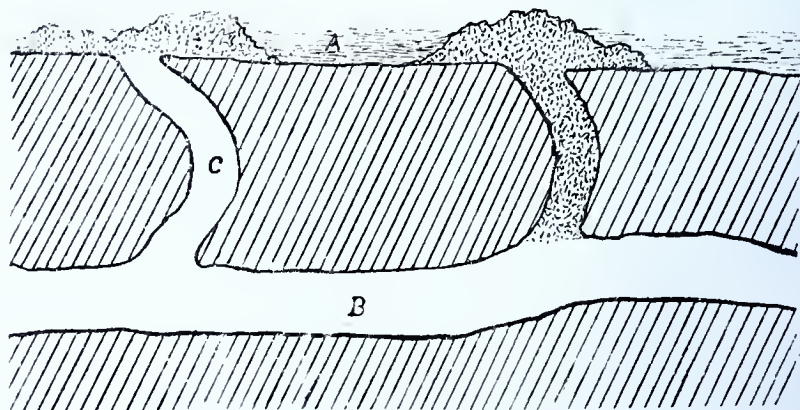


FIG. 4.

Fig. 4 illustrates, diagrammatically, a burrow of this species. B is the main run way from 12 to 20 inches below the surface A. C is a branch burrow from main runway to surface, affording a means of getting rid of the excavated earth. This branch is represented as still open: to the right is another, which, having served its purpose is plugged with earth, the mound on top marking its location.

The plan of the mole's burrow is exactly the same except that the main runway may not be as deep, and in addition to what is shown in Fig. 4 there frequently is an additional burrow close to the surface, forming that characteristic ridge often seen on our lawns and among our garden plants. Furthermore we have never found a mole's branch burrow open, except where it has been made beneath the snow; upon the melting of the snow the open hole is seen. This characteristic, even if there is no ridge caused by the surface burrow, will at once enable one to tell whether he is troubled with a gopher or mole, for the last made branch burrow of the gopher is often open, and in fact at certain hours in the day the occupant may be seen thrusting his head out, while busily engaged in getting rid of the earth which has accumulated within. This the mole does not do, and although we often see his mound moving before our eyes and visibly growing larger, the little depredator is concealed below. His minute bead like eyes, concealed beneath the velvety fur, but present nevertheless (this applies to this particular species, there are forms where the integument covers the rudimentary eye) would be of little service to him above ground; indeed it probably avails him very little in his wanderings below the surface, as his sensitive snout and delicate sense of smell are his chief guides in searching for food. As a rule the mounds of the mole consist of more finely pulverized soil than do those of the gopher, but they may be as large or larger than those of the latter. The burrows of the mole are, of course, smaller than the gopher burrows.

The first figure in Plate III at the end of this article is a male pocket gopher, dorsal view; the second is a female ventral view, and showing on the sides of the head the characteristic pouches (not connected with the mouth) opening below. This depredator often leaves its burrows at night on foraging expeditions and at this and other times when collecting food below ground these pouches are used as pockets in which the food is carried. Some observers state that the earth which is brought up from the main burrow is largely carried in the cheek pouches, while others flatly contradict this, asserting that the soil is pushed ahead of the animal. Both statements may be correct, we have never found any proof that they use the pouches as earth carriers. Both gophers and moles are active here during our winter season. The breeding season of the mole is early in this state, my diary states that on Feb. 28th of last year a pregnant female was captured containing three well developed embryos, and two days later another was captured with two embryos apparently within a few days of birth. I have, as yet, been unable to secure a pregnant gopher and hence cannot speak with accuracy of the exact date of their breeding time, but from the fact that I have caught one meadow mouse (*Arvicola*) May 10 with six nearly

full grown embryos, and since I have been unable to catch any female gophers at about this date, Feb. 15th to Mar. 15th approximately, I infer that the breeding season, that is for the first litter, is nearly contemporaneous in the three types mentioned. It is very evident that the best time to destroy them, if possible, is early in the season before the birth of the first litter.

The pocket gopher has not a little intelligence. Our horticulturist reports finding a nest stored with potatoes, the tubers lying in layers, and each layer separated from the adjoining layers by more or less dried grass. Furthermore the entrance to this nest, or at least one entrance, was from below, affording a system of drainage quite desirable in this country of wet winters.

It is a common thing to see gopher mounds arranged in a straight line from the side of a field or garden to some fruit tree or potato, parsnip, or carrot patch, indicating that his main burrow beneath the surface has been pushed directly to these sources of food supply.

REMEDIES FOR THE POCKET GOPHER.

Poisoning:—We have introduced powdered strychnine into pieces of potato an inch square and placed this bait down the branch burrow, or even as far in as the main burrow, with fair success. We have never had conclusive evidence that the animals were poisoned, except that digging ceased in that neighborhood which was pretty convincing proof that the strychnine had done its work.

This has proved most effective in the absence of other succulent root crops which may be more tempting to the gopher. And inasmuch as he may push out the bait with a lot of earth, before he fairly reaches it, it has been found best to put into the burrow more than one piece.

It goes without saying that *strychnine, being a deadly poison, should be kept under lock and key*, out of the way of children and others ignorant of its use.

Wakelee's Poisoned Wheat is claimed by some to be not only efficacious against the so-called "Digger Squirrel" but to be also a good remedy for the pocket gopher. If this is so, it must be at times when other more juicy food is scarce.

Shooting:—A handy shotgun is very effective. The pocket gopher works during the night, and is quite likely to be found digging *early in the morning, again about noon and again late in the afternoon*. At these times he frequently thrusts his head out of his hole and a few pellets of shot will kill him.

But the farmer or the orchardist can not afford to spend time in watching gopher holes, and their best resources are poisons and

Traps:—There are many so-called gopher and mole traps on the market but apparently very few which can be profitably purchased.

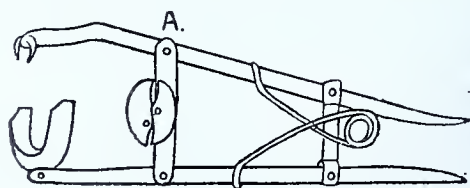


FIG. 5.

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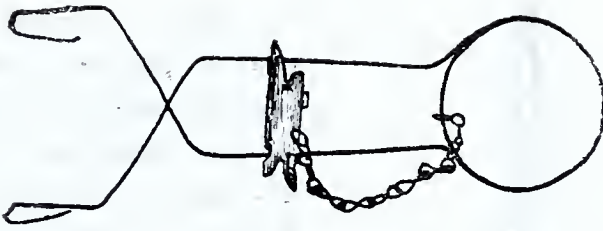


FIG. 6.

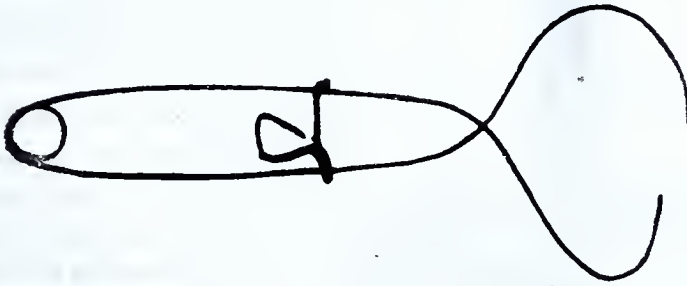


FIG. 7.

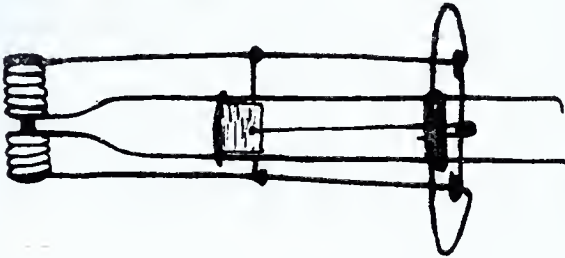


FIG. 8.

Fig. 5 above shows a gopher trap which has been on the market a number of years. Fig. 6, 7, and 8 represent other traps (all set), costing at retail 25 cents each. Specimens of each were donated the station for trial and we have worked with them for two years and find them of little if any value. A few young, undersized gophers have been caught, but it has almost invariably happened that the wily rodent has covered them up with earth, or possibly, in a few instances, left a few hairs on the points (in the case of the trap shown in Fig. 8) showing plainly that the trap is not strong enough.

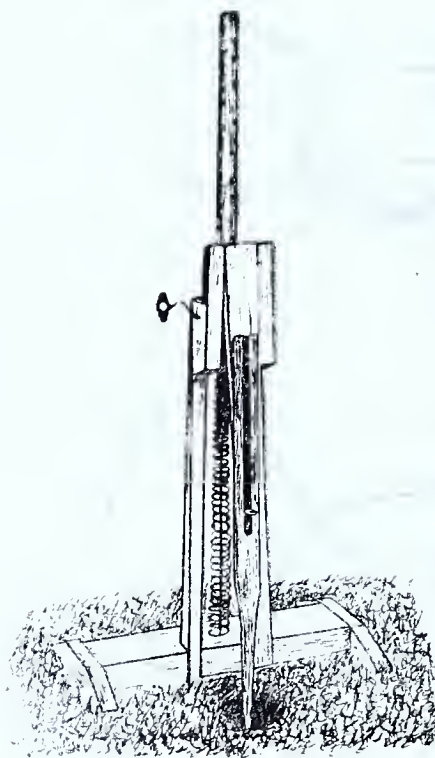


FIG. 9.—The Picard Gopher and Mole Trap.

DESCRIPTION OF PICARD TRAP AND DIRECTIONS FOR SETTING.

It is about two feet high. Through the base-board runs a brass spear, which is fitted into the lower end of a wooden rod, the latter working up and down in a hole in the top of the trap. A triangular piece of iron (shown attached at one side in cut) serves as a trip bar and when the trap is set keeps the spear up and is lightly caught under a piece of iron on the trigger which latter (see Fig.) swings easily on a hinge. As shown in figure a sliding piece, pointed at the end is attached to the trigger and can be adjusted to any length. The downward pull on the spear is brought about by a strong brass spring as shown.

In setting, a branch burrow which is open is found (C, fig. 4) or one is opened with a trowel, and the spear forced down *perpendicularly* through the soil, about six or eight inches from opening, *so that it passes directly through the center of the burrow. The base must lie squarely on the ground. The spear is then worked several times up and down through the soil, that there may be no binding when sprung.* Before setting, the pointed end of the trigger is worked back and forth, to see that the soil does not impede its movements. The point should be within an inch of the bottom of the mouth of burrow.

A stone or heavy clod of earth is then placed on the base on each side to keep trap steady when sprung. The wooden rod is then raised, the trip bar adjusted and the trap is set.

The principle is this: the gopher will sooner or later stop up this branch burrow. Or, seeing the pointed stick at his doorway, he at once proceeds to push out a lot of earth to protect his domicile from what may appear a sus-

Fig. 9 represents, a trap, which we have found very useful against both gophers and moles. The cut shows the trap set for a gopher. It is made by John Picard, St. Paul Marion Co. Oregon. and this particular trap we purchased from J. B. Mount Newberg Oregon for \$2.50. This is too high a price, and the maker could increase his sales ten fold if he would sell them at a more reasonable cost. Numerous letters to Mr. Picard relative to this point elicit no reply whatever and Mr. Mount has recently written us that he has not seen nor heard from the manufacturer, whom we understand is a farmer well known in that locality, for some time.

picious object. The earth pressing against the trigger point, springs the trap, and the gopher, behind the earth, is speared.

We have used this trap successfully against both gophers and moles.

What failures we have met with have been attributed to not gauging correctly the distance between trigger and point where spear enters burrow. In one instance, when the trap was set in a patch of peas, the gopher pushed against the trigger himself, issuing from his hole to nibble the delicate bait close at hand, and it was not until the above distance had been shortened, that he was captured. One can dig to the main burrow (B. Fig 4.) and set the trap there. But in this case it is generally impossible to tell from which direction the gopher will come, and a second setting may be necessary. By introducing a small bit of wood above the screw between the sliding part of the trigger and its upper part, an angle may be made between these two parts, and the lower point thus brought nearer the course of the spear. It has been found necessary to do this in setting the trap for moles.



FIG. 10.
Gopher Gun.

Fig. 10 shows another trap which we have used against both gophers and moles with success. It is represented as set. It is, very efficacious, and though requiring more care in setting than the Picard trap, there are probably less chances of failure when the details are carefully attended to. This trap is about 16 inches long and no description is necessary. It is of course, a fire-arm, and as such has to be handled carefully. It is for sale by O. Dickenson of Salem Oregon for \$4.00. He states that he will have the exclusive sale of these traps for the next four years, and that the inventor has applied for a patent. It is needless to say that we regard four dollars as a very high price for this gun. Undoubtedly lessening the price would increase the sales. The agent states that during a single season, with one gun, he has killed nearly a hundred gophers. It is certainly very killing. In setting, the earth should be so hollowed out with a trowel that the muzzle, which is placed 4 or 6 inches down the burrow lies directly in the middle line, the barrel parallel to the long axis of the burrow; the gun should lie squarely on the ground, and care should be taken to see that the wire plays freely back and forth. On the point of this wire is firmly placed some object to blunt it, a piece of wood, or small cork, or better, a small piece of carrot, potato or parsnip. Only a small charge is necessary, a thimble-full of powder, and twenty pellets of No. 3 shot will do very nicely. A water proof cap is fitted tightly to the nipple, the hammer is drawn back and caught. This applies to the branch burrow, which has either been found open or has been opened with a trowel. It is set in the main burrow in the same way, but, as in the case of the previous trap, there is an uncertainty of the direction of the gopher's approach. The animal, in pushing the earth before him, literally shoots himself.

Remedies For Moles.

The last two traps described have worked very well with us. When used against moles they are set in the same way as for gophers. The branch burrow of the mole is always closed, that would therefore have to be opened; and as this burrow is shorter than that of the gopher, the muzzle of the gopher gun cannot be thrust down so far, *it projects into the hole only an inch or two*, that the mole (and the same thing applies to the gopher) may be fairly in the branch burrow before the gun is discharged.

In setting the Picard trap for moles the distance between the lower point of the trigger and the point where the spear enters the burrow, *should not exceed four or five inches*. This is effected by the introduction of a small bit of wood, as above described, between the two parts of the trigger.

Poisoning.—At the suggestion of a party who had been experimenting on a mole in confinement, we tried poisoning small pieces of beef with powdered strychnine, opening the burrows, introducing the bait as far as possible with a spoon and then covering with earth again. In a number of cases where this was done, digging ceased, but not in all. It would seem that the scarcity of their natural food, or its abundance, would affect the efficacy of this method.

Other Means of Killing.—When one is so fortunate as to observe the soil of a mole's mound moving, indicating that the depredator is at work below, a well aimed thrust of a fork will frequently be successful in transfixing the hidden animal.



FIG. 11.

Fig. 11 illustrates a trap modelled after an English pattern. It is represented as set. There should be teeth filed in, or soldered to, the inner edge of the jaws, and the steel spring should be very strong. The centre piece, which hangs down between the jaws and keeps them spread apart, is the trigger. Almost any blacksmith can make this trap at little expense, and we believe, with the two improvements above mentioned, which improvements are found on the English trap, that this would be a killing instrument. In setting, the main burrow is cut into and into the cut is inserted the trap in the position indicated in the figure. The opening above, is covered with dried grass or other rubbish to keep out the light. One party reports that he fills in the hole, in which he has placed his trap, with soft earth, and rarely fails to catch the mole as it is digging its way through the yielding obstruction.

PLATE III.





FIG. 12.

Fig. 12 represents a mole trap which is intended to be so set as to spear a mole as it runs through the *surface burrow*. When a newly made ridge is seen, the trap is pressed into the ground in such a way that the two heavy iron pieces on the side straddle the ridge, and the pointed wires project through the burrow. These points are then raised, the ridge slightly flattened beneath them and the plate, which connects with the trigger, lies on top of this flattened surface. The mole in forcing its way through the burrow, raises the plate, springs the trap and receives the pointed wires. We have not tested this trap sufficiently to warrant an expression of opinion upon its merits.

"The California Ground Squirrel."
"Digger Squirrel." "Gray Gopher."
Spermophilus beecheyi (Cuv.).

Our wheat crop and fruit trees suffer from this pest which is so well known that no description is necessary.

Remedies.—Wheeler's Bisulphide of Carbon is recommended for this rodent. We have not used it.

To prevent "ground squirrels" from gnawing fruit trees, a California orchardist suggests tying newspapers round the tree trunk in such a way that four inches of the paper at the upper edge extends out. The rattling of the paper when the squirrels attempt to cross it will frighten them.

One of the most effective means for their destruction seems to be a trap in successful use in the large orchard belonging to J. H. Stewart at Medford, Or. He places, in fence corners about his orchard, boxes about one and one half feet square at the ends and about four feet long. The top and two ends are united and can be lifted off the box. The ends do not reach quite to the bottom board, an open space of about four inches intervening, [see Fig. 13], and enabling the animal to run through the box and out at the other end. On the bottom, midway between the two ends, pieces of pork rind are securely nailed. These pieces have been first soaked in a solution of strychnine, made by boiling strychnine in water. Kernels of corn may be steeped in the same solution and placed with the pork as an additional bait, but is more easily displaced and hence more likely to be eaten by some animal for which it is not intended. But the pork rind cannot be

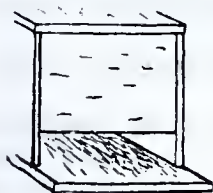


FIG. 13.

removed. The top is fastened on to the box by means of a couple of nails, which can be easily pulled out when putting in new bait.

Mr. Stewart asserts that his trees are free from all attacks of this pest through using this very simple device.

Strychnine is not very soluble in water, but, if thoroughly boiled, enough will dissolve to make a poison. It would seem that if the solution were sweetened it would render it more palatable.

Notes.

The burrows of moles are sometimes found running in patches of carrots, etc., and the finding of a gnawed root in the course of the burrow would seem to implicate our friend with velvety fur, but a species of meadow mouse [*Arvicola*] frequently uses this passage way and is believed to be the depredator.

In the spring we suddenly find, in localities, in our fields and meadows, numerous small holes about two inches in diameter. These are made by meadow mice.

A party in Portland Or. who was convinced that moles were eating valuable bulbs, kept three specimens in confinement for some time and found they would eat the following substances: wheat, pears, beef, pork, mutton, and peas. Witnessing one fellow eat the latter quite ravenously was pretty convincing proof to the writer that, under some circumstances, at least, they are not strictly carnivorous.

In this connection we quote from a recent writing of Amos W. Butler of Indiana. Speaking of moles he says, "They generally, if not always, feed upon animal food, insects, grubs, larvæ, earth worms, slugs and almost any sort of animal food appears to be eaten by them. Many suppose them to injure garden vegetables by eating the roots. Such is not thought to be the case usually, however, if at all. They excavate a runway along the row of plants so that they may secure the insects there found, and it is supposed the meadow mice are the forms which utilize the highway thus provided that they may secure a meal of their favorite food from the succulent roots of many plants. *I have, however, never been satisfied that the mole, in sandy soil, is not very destructive to young pea sprouts just as they are emerging from the ground.*"

In a number of moles caught in March 1892 the stomach contents consisted almost entirely of finely triturated earthworms, no vegetable matter being present. In one captured in Jan. 93 the stomach contained nothing but a few delicate fibrous roots.

Jack Rabbits, though not belonging under the head of "gophers and moles," are such a pest in parts of Eastern Oregon that they deserve a passing notice.

In some portions shooting them on moonlight nights as they come into the young orchards is practiced.

Pieces of poisoned melon scattered plentifully through an orchard has been found helpful, the rabbits preferring the melon to the bark. Any vegetable of which they are especially fond might be used when melons are lacking. The two following recipes are recommended as making ef-

fective poisons: Add 9 gals. of water to 100 lbs. of wheat. To this add 1 lb. of phosphorous, 1 lb. of sugar and 1 oz. of oil of rhodium. Bring to a boil and let stand over night. The next morning stir in enough flour to make a kind of paste. Scatter this over ground frequented by the animals. The second recipe is $\frac{1}{2}$ teaspoonful of powdered strychnine, two tablespoonfuls of fine salt, four tablespoonfuls of granulated sugar. Shake well together in a tin box. If placed on boards this becomes hard and rabbits lick it eagerly.

DESCRIPTION OF PLATE III.

The first figure on left is a male pocket gopher [*Thomomys bulbivorus*] dorsal view. The next figure is a female gopher, ventral view to show opening of pockets on side of head. To the right of the head of this specimen is a small shrew. The shrews are small mice-like animals, shy and retiring in their habits, belonging to the same order as the moles, strictly carnivorous and very pugnacious. They kill and eat many field mice, and not infrequently are given to killing and eating each other.

The large figure to the right of the female gopher is a mole [*Scapanus Townsendii*] and to the right of that two meadow mice belonging to the genus *Arvicola*. The first skull on the left is that of a pocket gopher, the next one that of a mole, and the smaller one on the right that of a field mouse. The picture does not show the difference in dentition between the two orders *Rodentia* and *Insectivora*, for which purpose the skulls were inserted. The female gopher pictured was $9\frac{1}{2}$ in. long and from this the length of the other specimens can be easily computed. The two gophers were taken from specimens in the flesh; the mole was stuffed, as were also the two meadow mice. The shrew was an alcoholic specimen.

ADDENDA

The following notes were made up too late to be incorporated in the body of the text, and through the courtesy of the printer are here appended.

March, 28th, 1893—A pocket gopher just secured, containing four young embryos. See page 15.

From the cheek pouches [not to be confounded with the pockets of the pocket gopher] of a ground squirrel, captured at 10 a. m. on a day in last September, by Prof. F. E. Loyd of Forest Grove, 21.1 grams or 50 c. c. of oats were taken, an indication of the amount of damage caused by these pests.

The galvanized iron tank figured in Plate II cost the department about \$30.00. The wooden frame upon which it rests, and the cover cost, together, about \$4.00.

In Fig. 2 Plate I, the light colored spot on each wing of the first codling moth figured is due to a break in the wing.

The details in the beetles [same figure] cannot be shown with the means our photographer has at his disposal.

Bulletin No. 12 from the Wyoming Experiment Station is just received,

containing remedies for "Ground Squirrels." They advise the use of Bisulphide of Carbon manufactured and sold by E. R. Taylor, Cleveland, Ohio, for 10 cents per lb. on board cars, at Cleveland. A gallon weighs about 10 pounds and is sufficient to treat 160 to 200 holes. The usual method is practised; saturate a piece of cotton the size of an egg with the fluid, throw it down the burrow and stop the opening with earth. *Never bring this inflammable agent near a light of any kind!!*

